Improving the ACIS−S3 Spectral Resolution via a Grade−Dependent Correction?

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ANALYSIS

In Figures 1, 2, and 3, we present the G0, G2, G3, G4, and G6 grade distributions from OBSID 62895 @ 1.5 keV, @ 4.5 keV, and @ 5.9 KeV, respectively. A Gaussian was fit to each spectrum and their fit parameters are tabulated in Table 1. The G2346 distributions for both the CXC data & the PSU CTI corrected data (Townsley, et al. 2000) were adjusted so that their line peaks coincided with the G0 line peak. The adjusted G02346 spectra were then re−summed @ each line energy and are presented in in Figs 4, 5, and 6 (dashed lines). The original CXC and CTI corrected G02346 spectra are also plotted (solid lines). Each summed spectrum was also fit with a Gaussian. Their fit para−meters are listed on each plot. By comparing the fit parameters from the modified G02346 spectrum against the original spectrum for both the CXC and the CTI corrected data, no significant diff−erences are found. The line sigma in the CTI corrected data are 4%, 9%, and 11% smaller @ 1.5 keV, 4.5 keV, and @ 5.9 keV.

RESULTS

We have analysed ACIS data of the external calibration source to determine the stability of the S3 gain as well as to characterise the grade−dependent spectral resolution of the ACIS−S3 CCD. Preliminary results from a work−in−progress are presented. We find that the computed line peak in PI space has shifted down−wards by ~ 1 PI channel @ 1.5 keV, 1.6 PI channels @ 4.5 keV, and 1.8 PI chan−nels @ 5.9 keV over a 3.25 year time period. We find that this shift can be correct−ed by applying "corr_tgain". This tool is available from the CXC. Over this time period, the line sigma has changed by ~ 5%, 4%, and 5% at 1.5 keV, 4.5 keV, and 5.9 keV, respectively, due to CTI. This can be largely corrected by applying the Pennsylvania State University (PSU) CTI corrector. While the line peaks in the CTI corrected data are at lower PI channels, this is presumably accounted for in the PSU response matrices. We have also attempted to improve the spectral res−olution of S3 by investigating the G0, G2, G3, G4, and G6 grade distributions. We find no significant change in line peak nor line width by such a correction when data from the entire CCD are summed. We are in the process of investigat− the position dependency of this effect. Only modest improvements are expected.

TIME DEPENDENCE OF S3 GAIN

The same analysis that was performed for OBSID 62895 was re−peated for OBSID 62847, another observation of the external cal−ibration source taken on May 30, 2003. The G02346 grade dis−tributions for both the CXC and the CTI corrected data are pre−sented in Figs 7, 8, and 9. Each spectrum was again fit with a Gaussian (see Table 2), and the line peaks adjusted so as to coin−cide with the G0 line peak. The G02346 spectra were then re−summed and are presented in Figs 10, 11, and 12 for comparison with the original G02346 spectrum as derived from the CXC and the CTI corrected event list. Notice that the line peaks for OBSID 62847 are shifted slightly to the left of the line peaks from OBSID 62895. Clearly, the temporal eveolution of the S3 gain over 3+ yrs is small. Nevertheless, this shift can be corrected by applying "corr_tgain" − a gain correction tool available via the contributed software page* at the CXC and also included in the CIAO V3.0 release. The "corr_tgain" line sigma are only slightly modified.

(*http://cxc.harvard.edu/cont-soft/soft-exchange.html)

OBSID 62895 − Feb. 20, 2000

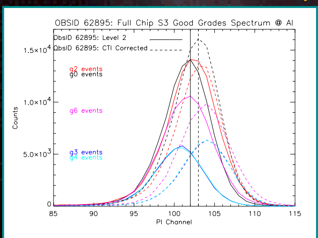

Figure 1: Grade Distribution @ Al

(E = 1.5 keV)

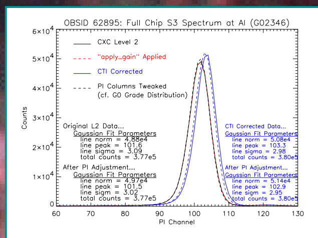

Figure 4: Full Chip Spectrum @ Al

(E = 1.5 keV)

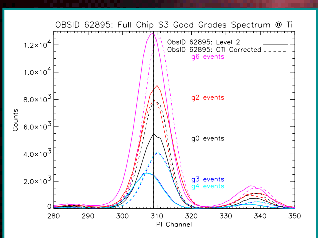

Figure 2: Grade Distribution @ Ti

(E = 4.5 keV)

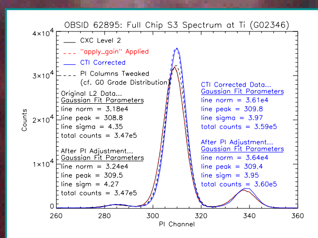

Figure 5: Full Chip Spectrum @ Ti

(E = 4.5 keV)

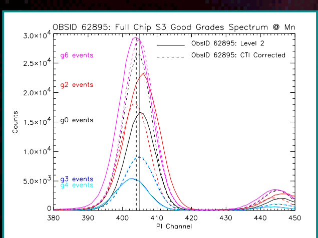

Figure 3: Grade Distribution @ Mn

(E = 5.9 keV)

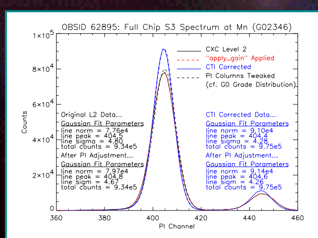

Figure 6: Full Chip Spectrum @ Mn

(E = 5.9 keV)

Table 1: Gaussian Fits to OBSID 62895 Grade Distributions

@ Al — CXC Level 2 / CTI Corrected

Grade	Peak	Sigma	Norm	PI Shift
0	101.6/102.8	2.86/2.83	1.39e4/1.60e4	0/0
2	102.3/103.1	3.08/2.87	1.41e4/1.34e4	−1/0
3	100.6/104.0	2.97/3.00	5.65e4/6.23e4	+1/−1
4	100.6/100.3	2.98/3.03	5.62e3/6.25e3	+1/−1
6	101.6/103.8	3.19/3.17	1.05e4/9.59e3	0/−1

@ Ti — CXC Level 2 / CTI Corrected

Grade	Peak	Sigma	Norm	PI Shift
0	309.4/309.4	3.91/3.83	5.44e3/7.95e3	0/0
2	309.7/308.9	4.43/3.91	8.91e3/7.92e3	0/+1
3	307.4/310.2	4.20/3.93	2.62e3/4.02e3	+2/−1
4	307.2/310.1	4.21/3.94	2.59e3/4.05e3	+2/−1
6	308.5/310.3	4.32/4.02	1.29e4/1.25e4	+1/−1

@ Mn — CXC Level 2 / CTI Corrected

Grade	Peak	Sigma	Norm	PI Shift
0	405.2/404.4	4.20/4.08	1.66e4/2.64e4	0/0
2	405.7/403.5	4.90/4.25	2.30e4/1.81e4	−1/+1
3	402.7/404.8	4.67/4.37	5.40e3/9.00e3	+2/0
4	402.7/404.7	4.59/4.34	5.42e3/9.20e3	+2/0
6	403.7/404.7	4.77/4.36	2.94e4/2.88e4	+1/0

(Please See Figs. 1, 2, & 3)

Table 2: Gaussian Fits to OBSID 62847 Grade Distributions

@ Al — CXC Level 2 / CTI Corrected

Grade	Peak	Sigma	Norm	PI Shift
0	101.3/102.3	2.99/2.99	1.23e4/1.44e4	0/0
2	102.1/102.4	3.18/2.99	1.30e4/1.19e4	−1/0
3	100.2/103.4	3.18/3.19	4.86e3/5.54e3	+1/−1
4	100.2/103.3	3.18/3.21	4.82e3/5.55e3	+1/−1
6	101.3/103.0	3.31/3.30	9.47e3/8.41e3	0/−1

@ Ti — CXC Level 2 / CTI Corrected

Grade	Peak	Sigma	Norm	PI Shift
0	310.6/309.2	4.01/4.09	4.91e3/7.54e3	0/0
2	311.0/307.9	4.49/4.16	8.84e3/6.99e3	0/+1
3	308.4/309.7	4.41/4.26	2.33e3/3.75e3	+2/0
4	308.3/309.6	4.42/4.28	2.29e3/3.83e3	+2/0
6	309.5/309.2	4.48/4.24	1.23e4/1.14e4	+1/0

@ Mn — CXC Level 2 / CTI Corrected

Grade	Peak	Sigma	Norm	PI Shift
0	405.6/404.4	4.37/4.36	1.45e4/2.47e4	0/0
2	406.1/402.5	5.01/4.57	2.28e4/1.56e4	0/+2
3	402.8/404.4	4.93/4.68	4.69e3/8.65e3	+3/0
4	402.7/404.4	4.89/4.67	4.64e3/8.82e3	+3/0
6	403.8/403.6	5.03/4.67	2.74e4/2.56e4	+2/+1

(Please See Figs. 7, 8, & 9)

OBSID 62847 − May 30, 2003

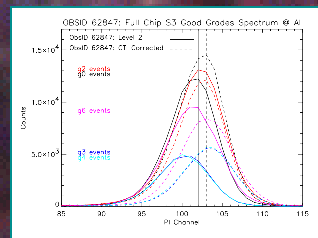

Figure 7: Grade Distribution @ Al

(E = 1.5 keV)

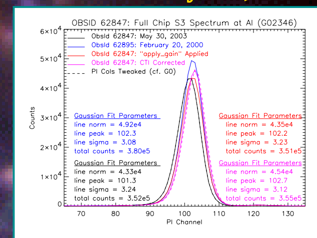

Figure 10: Full Chip Spectrum @ Al

(E = 1.5 keV)

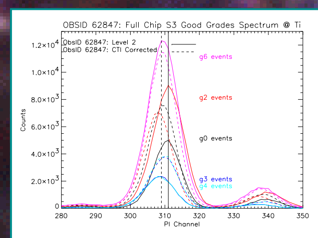

Figure 8: Grade Distribution @ Ti

(E = 4.5 keV)

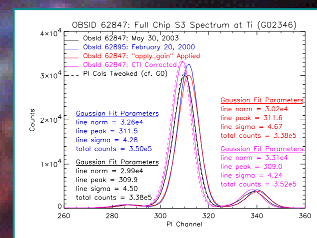

Figure 11: Full Chip Spectrum @ Ti

(E = 4.5 keV)

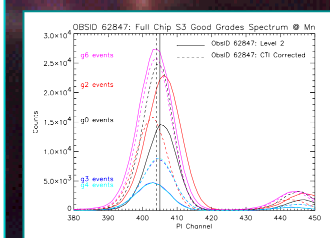

Figure 9: Grade Distribution @ Mn

(E = 5.9 keV)

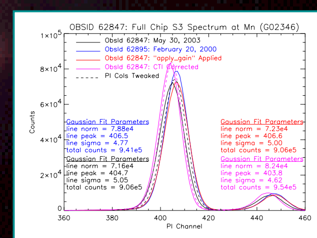

Figure 12: Full Chip Spectrum @ Mn

(E = 5.9 keV)